Land Monitoring

European Ground Motion Service

Project Presentation

SPECIFIC CONTRACT No 3436/R0-COPERNICUS/EEA.58362
Implementing Framework Service Contract No EEA/DIS/R0/20/011:
The end-to-end implementation and operation of the European Ground Motion Service as an integrated element of the Copernicus Land Monitoring Service.

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Standard project presentation v1.0 of 18 March 2021

European Ground Motion Service at a glance

Land Monitoring

- A new element of the Copernicus Land Monitoring Service.
- The first continental-scale InSAR ground deformation monitoring service. Based on full-resolution processing of all past and future Sentinel-1 (S1) satellite data, for high spatio-temporal resolution and millimetric precision.
- Typical ground displacements include: landslides, subsidence and uplift, volcanic and tectonic deformations. Enabling monitoring of the stability of slopes, mining areas, buildings, infrastructures, ...
- A new European geospatial dataset of unique value, from which other products/services can be developed.
- Exploiting advanced PS and DS InSAR processing algorithms, and ensuring seamless harmonization between the S-1 tracks.
- A 50 km grid GNSS model will also be realized to tie the InSAR products to the geodetic reference frame ETRF2014.
- Tools for visualization, exploration, analysis and download of the ground deformation measurements, as well as elements to promote best practices and user uptake will be provided.
- The first product, based on S1 data from 2015-2020, will be released in Q1 2022. Annual updates will follow.

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Content

ESA Sentinel-1 radar vision

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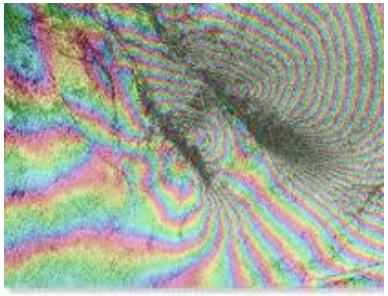
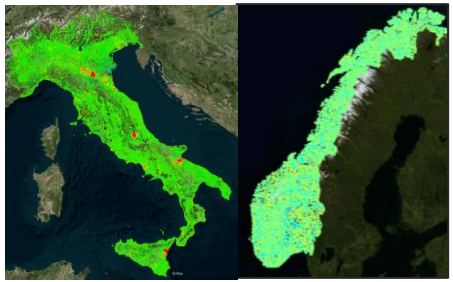
Background

Sentinel-1

High performance computers



Reliable algorithms



Past and present experiences

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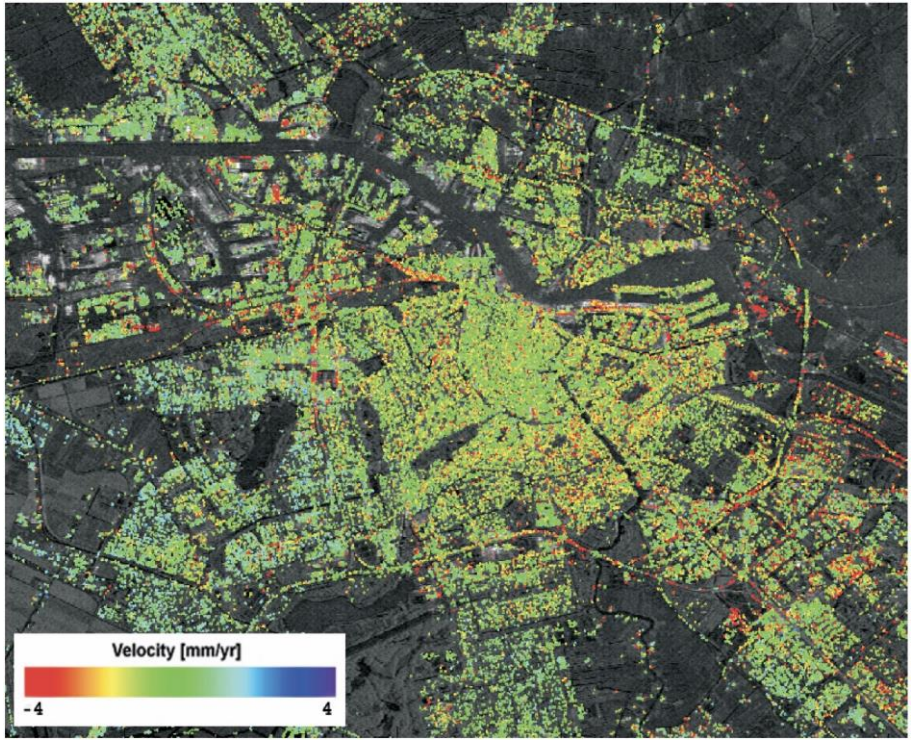
The European Ground Motion Service

- EGMS is the newest addition to the Copernicus Land Monitoring Service, managed by European Environmental Agency (EEA)
- EGMS will provide continental-scale, homogeneous maps of **ground motion**.
- Millimetre-per-year precision with full time-series included.



InSAR map of ground velocity in Amsterdam between 2003 and 2007: © ESA 2009.

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The European Ground Motion Service

Land Monitoring

- Typical ground displacements include: landslides, subsidence and uplift, volcanic and tectonic deformations.
- Products made by mass-InSAR-processing Sentinel-1 satellite data.
- Initial service coverage includes all Copernicus Participating States
- A new European geospatial dataset of unique value, and from which other products and services can be made.

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Implementation and ORIGINAL Consortium

Framework Service Contract between:

European Environment Agency and the ***ORIGINAL Consortium***, comprising:

e-geos AN ASI/TELESPAZIO COMPANY

TRE ALTAMIRA A CLS Group Company

NORCE

GAFAG an e-GEOS (ASI / Telespazio) Company

In collaboration with:

NHAZCA NATURAL HAZARDS CONTROL AND ASSESSMENT

Earth Metrics a measure on the world

GEOLOGICAL SURVEY OF NORWAY - NGU -

PPO.Labs

SG LECHNER TUDÁSKÖZPONT

DLR

Contract duration: January 2021 to December 2024.

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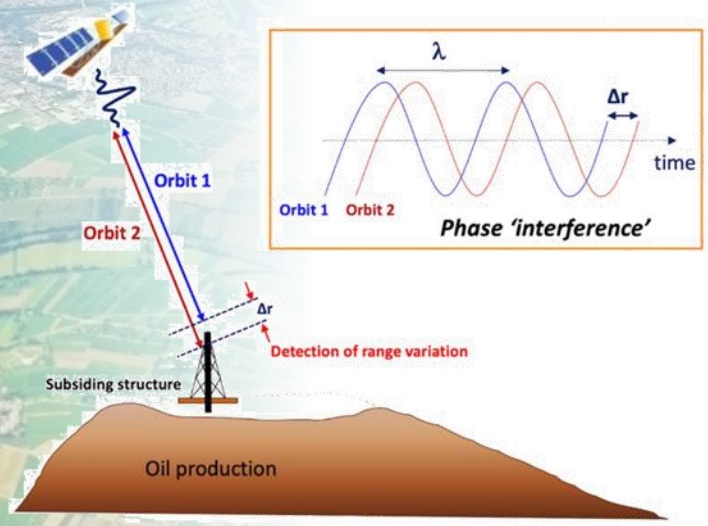
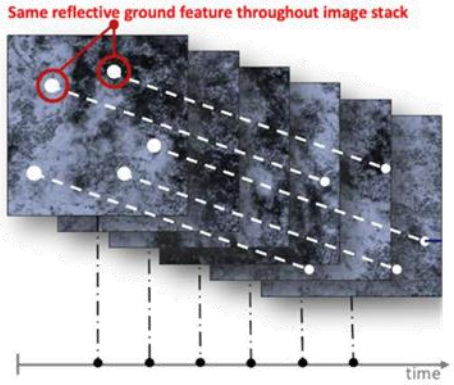
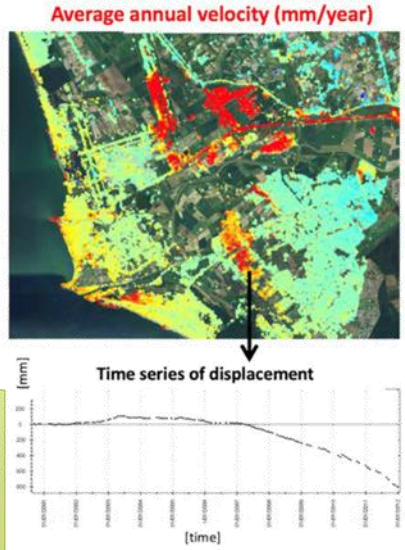
EGMS is based on 'InSAR'

- InSAR = Synthetic Aperture Radar (SAR) Interferometry.
- Multitemporal analysis using *Persistent Scatterer* (PS) and *Distributed Scatterer* (DS) interferometry techniques.







- Multiple image-acquisition approach, e.g. entire archives.
- Removal of atmospheric noise allows mm/year precision.
- Produces high-density data cloud with measurements from both 'point' and 'distributed' scatterers (PS+DS technique).
- Every point has an associated time-series of displacement.

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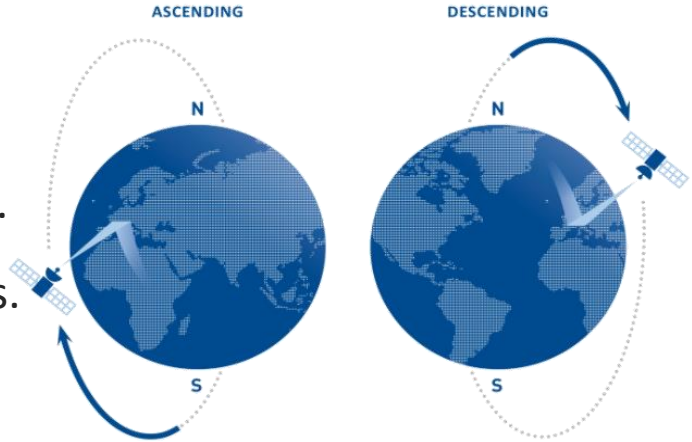
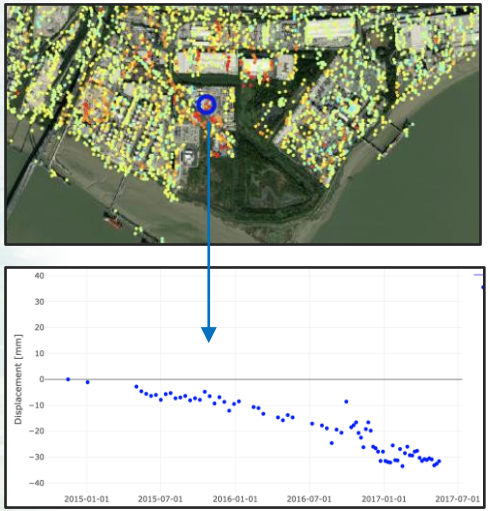
EGMS products

Based on:

- Maps of average annual velocity (mm/year).
- Time-series data for every measurement point.
- Ascending and descending satellite look-angles.





Average velocity in mm per year

InSAR point time-series plot

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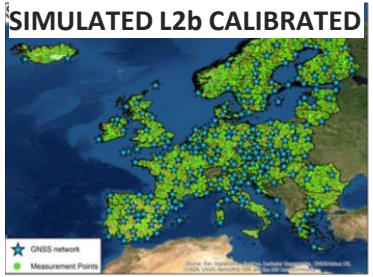
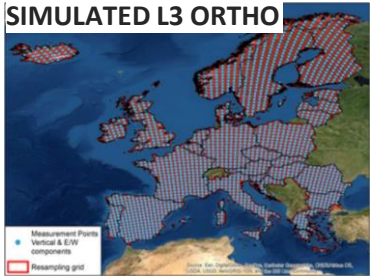
EGMS products

SIMULATED L2a BASIC

SIMULATED L2b CALIBRATED



SIMULATED L3 ORTHO



Basic

- **L2a product**
- Displacement data in the satellite line-of-sight.
- ***Relative to InSAR point.***
- Two look-angles.
- Captured at 20 m x 5 m resolution.
- For expert use.

Calibrated

- **L2b product**
- Displacement data in the satellite line-of-sight.
- ***Anchored to a GNSS reference frame.***
- Two look-angles.
- Captured at 20 m x 5 m resolution.
- For regular use

Ortho

- **L3 product**
- **Vertical and east-west displacement data.**
- Made from multi-look *Calibrated* product.
- Plotted to 100 m grid to coincide with other CLMS datasets.
- A useful aid to interpretation.

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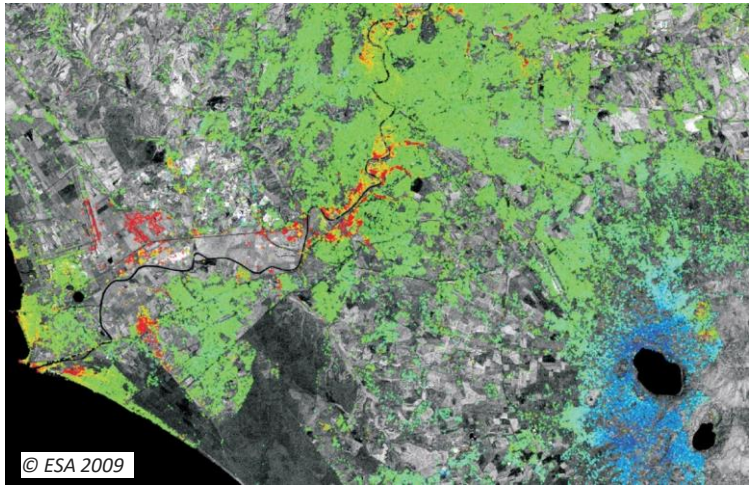
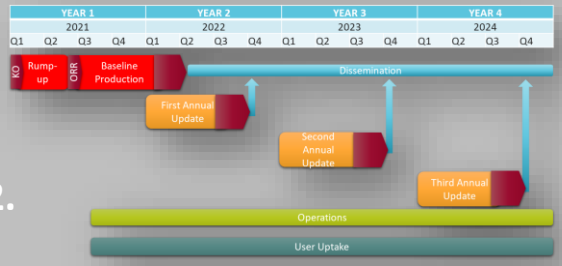
Service delivery

- EGMS products and services will be made **freely** available to all, **globally**.
- Visualisation and analysis via a dedicated webGIS.
- Data download available after registration via search interface.
- Accessible via the main *Copernicus Land Monitoring Services* site.



Delivery schedule:

- **Q1, 2022: Initial 5-year baseline spanning 2015 to 2020.**
- **Q3, 2022: First annual update adding data from 2021.**
- **Q3, 2023: Second annual update adding data from 2022.**
- **Q3, 2024: Third annual update adding data from 2023.**



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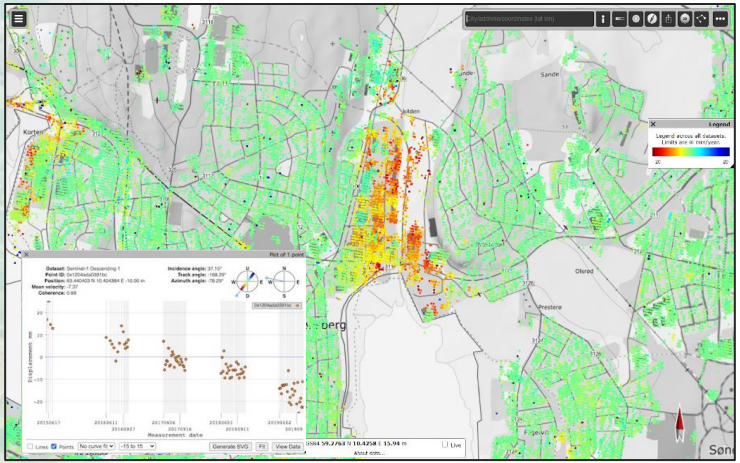
Service delivery: DAS

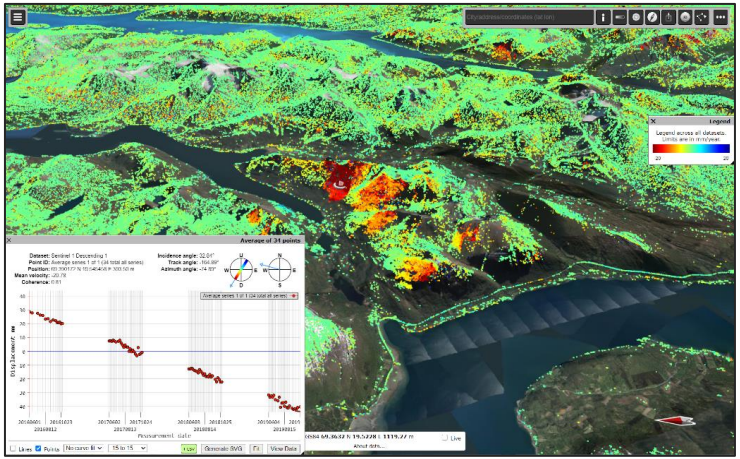
EGMS Dissemination & Archive System: a webGIS with added functionality.

- Plot the time-series of individual InSAR points to show displacement evolution and trends.
- Plot the average time-series for many InSAR points.
- After registration, freely download the data in various user-friendly formats.
- More features to be developed…

Standard map will display InSAR points colour-coded by mm/year velocity



3D viewing for analysis in areas of relief



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User Uptake

raise awareness… educate… stimulate…

Build user network

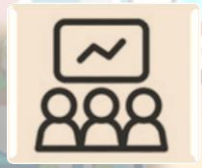
Educational Webinars /Tutorials

Newsletters

Thematic events

User Workshops

Support Services



Case studies

Collect feedback

EGMS documentation to be made available:

- End user requirements
- Algorithm theoretical basis
- Product description & format specification
- GNSS calibration
- Product user manual
- End user interface manual
- Quality assurance & control
- User uptake & communication plan

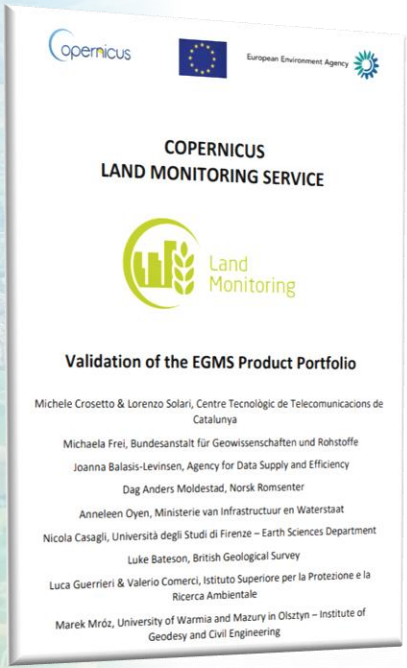
References:

EGMS White Paper (Sep 2017)
https://land.copernicus.eu/user-corner/technical-library/egms-white-paper

EGMS Specification & Implementation Plan (Jan 2020)
https://land.copernicus.eu/user-corner/technical-library/egms-specification-and-implementation-plan

Copernicus introduction to EGMS (current)
https://land.copernicus.eu/pan-european/european-ground-motion-service

Independent Validation



- EGMS products will be independently validated.
- Based on '*Validation of the EGMS Product Portfolio*' drafted by the EGMS Advisory Board.
- Validation will certify the quality of all EGMS products.
- An ITT for EGMS validation was launched in April 2021.

https://land.copernicus.eu/user-corner/technical-library/validation-approach-of-the-egms-product-portfolio

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Preliminary results on a test area

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Test Area – S1 tracks coverage

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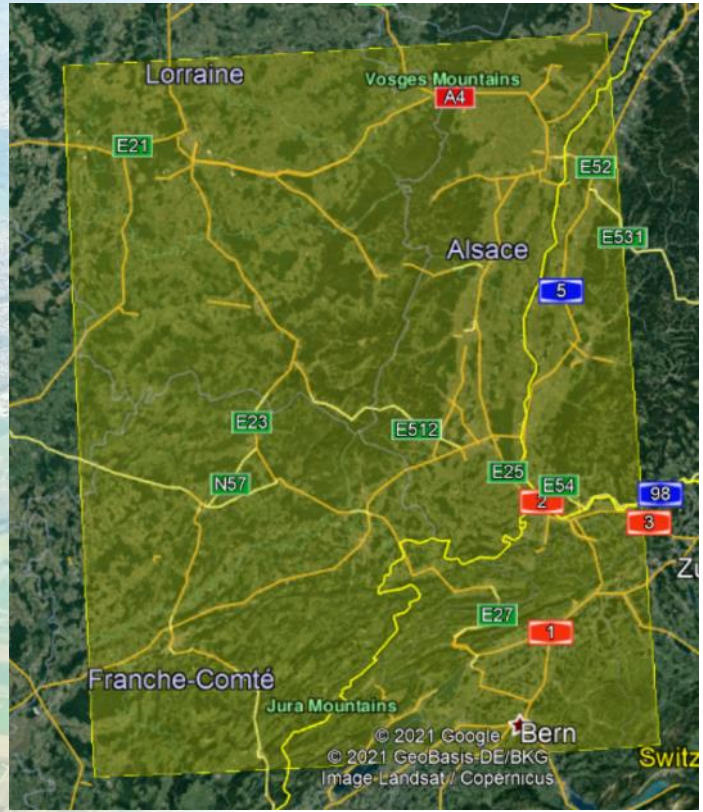
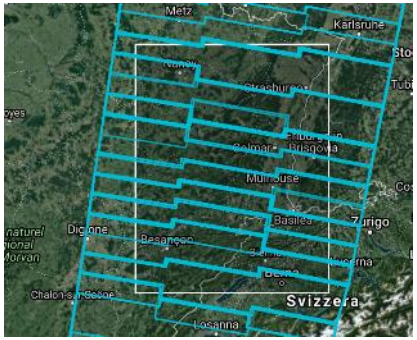


- Roughly 40,000 Km^2
- Well covered by S1 tracks
- Interesting from a CORINE perspective (Mountains, vegetation, towns, villages…)
- GNSS Availability



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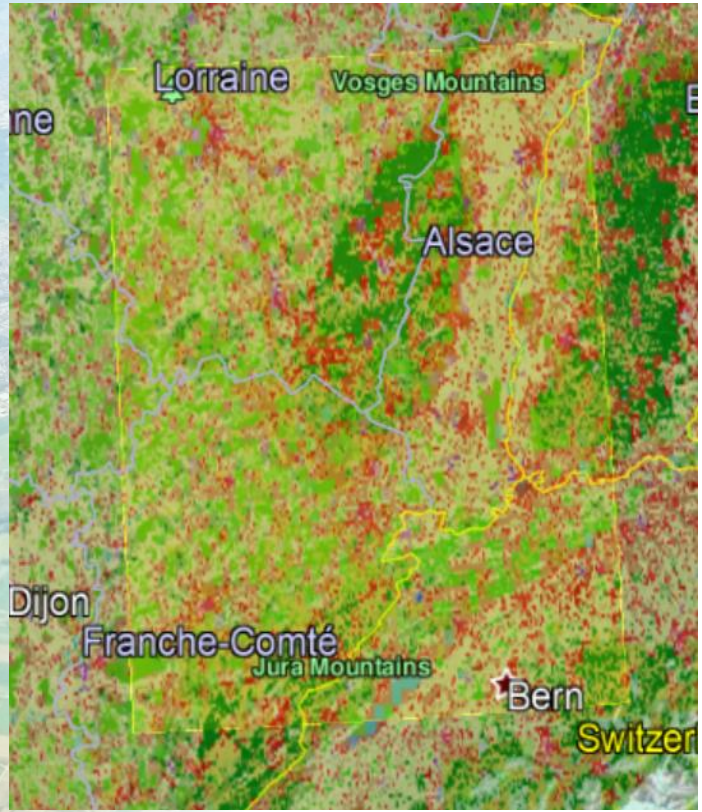
Test Area – CORINE land cover



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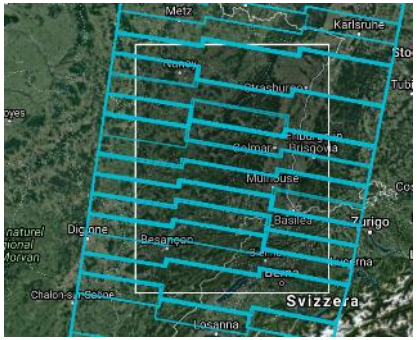

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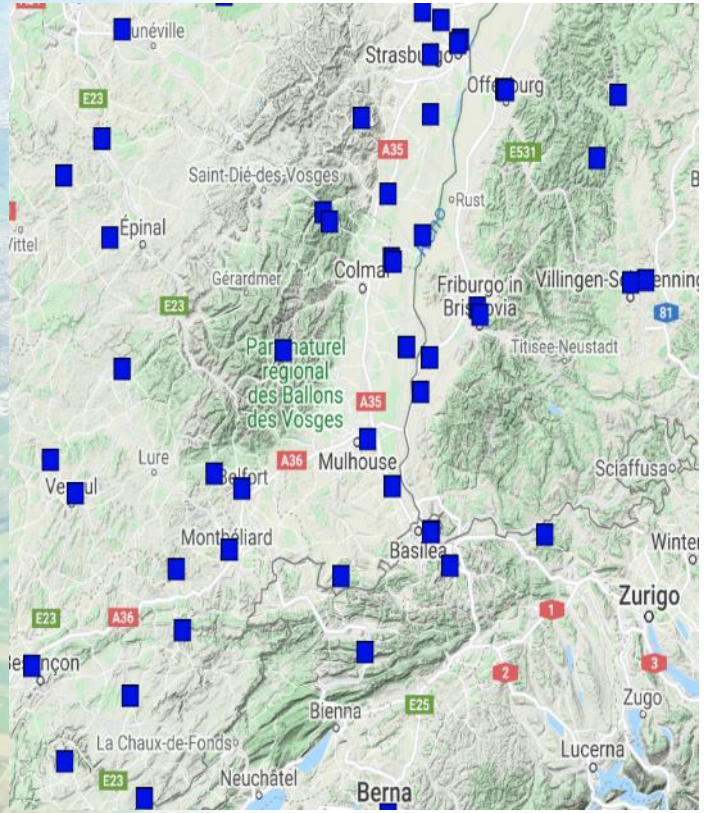
Test Area – GNSS availability



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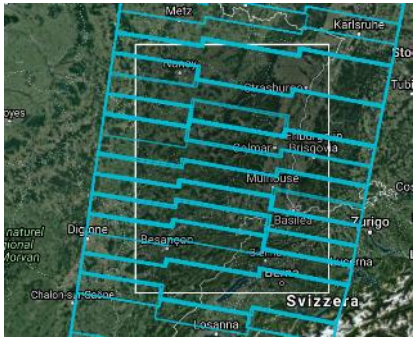

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Test Area – A stable area

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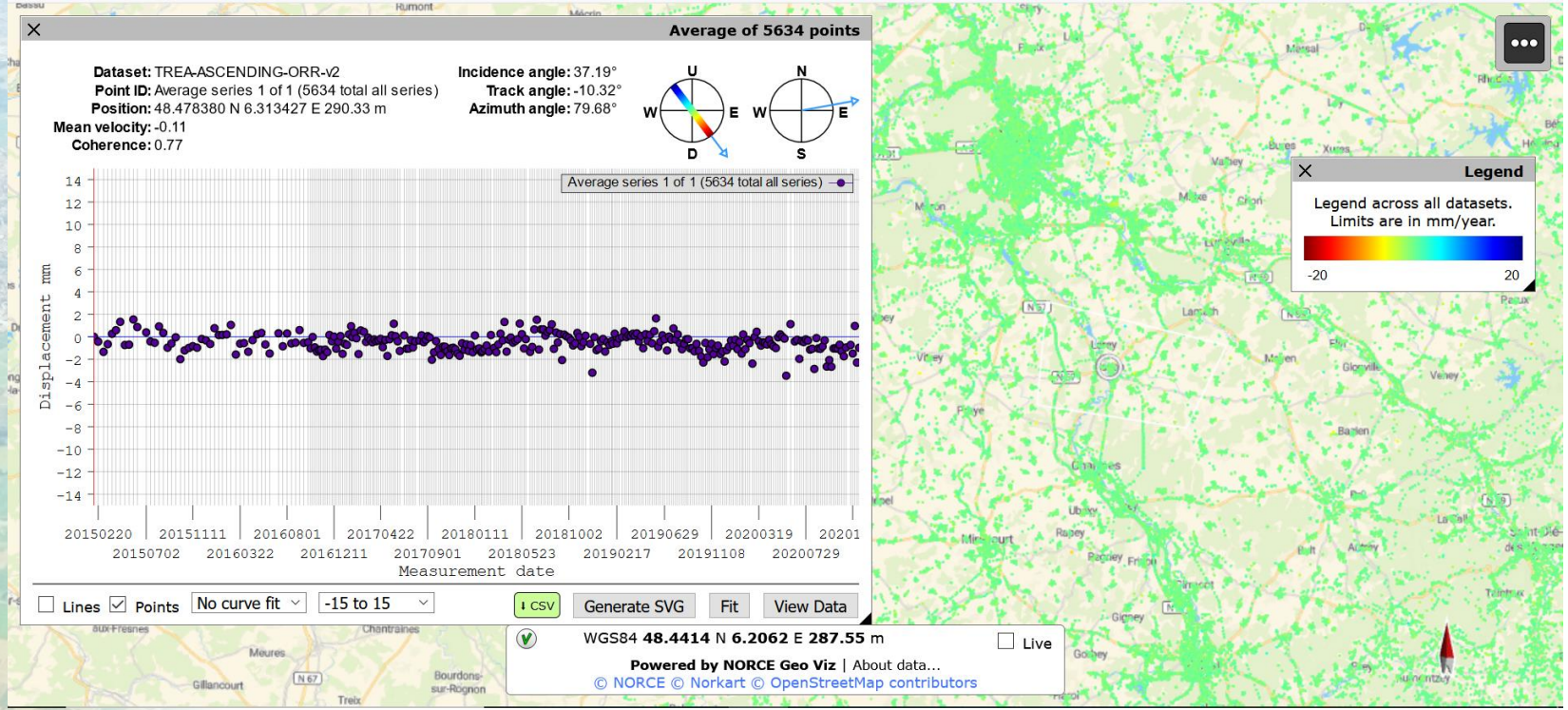
http://dev.insar.no/#llh=5.83255367,48.49051799,93394.81268972&look=-0.06734907,-0.74884605,-0.65931305&right=0.99482313,-0.00000000,-0.10162154&up=-0.07609895,0.66274333,-0.74496995&layers=aerial,maptiler-streets,TREA-ASCENDING-ORR-v2



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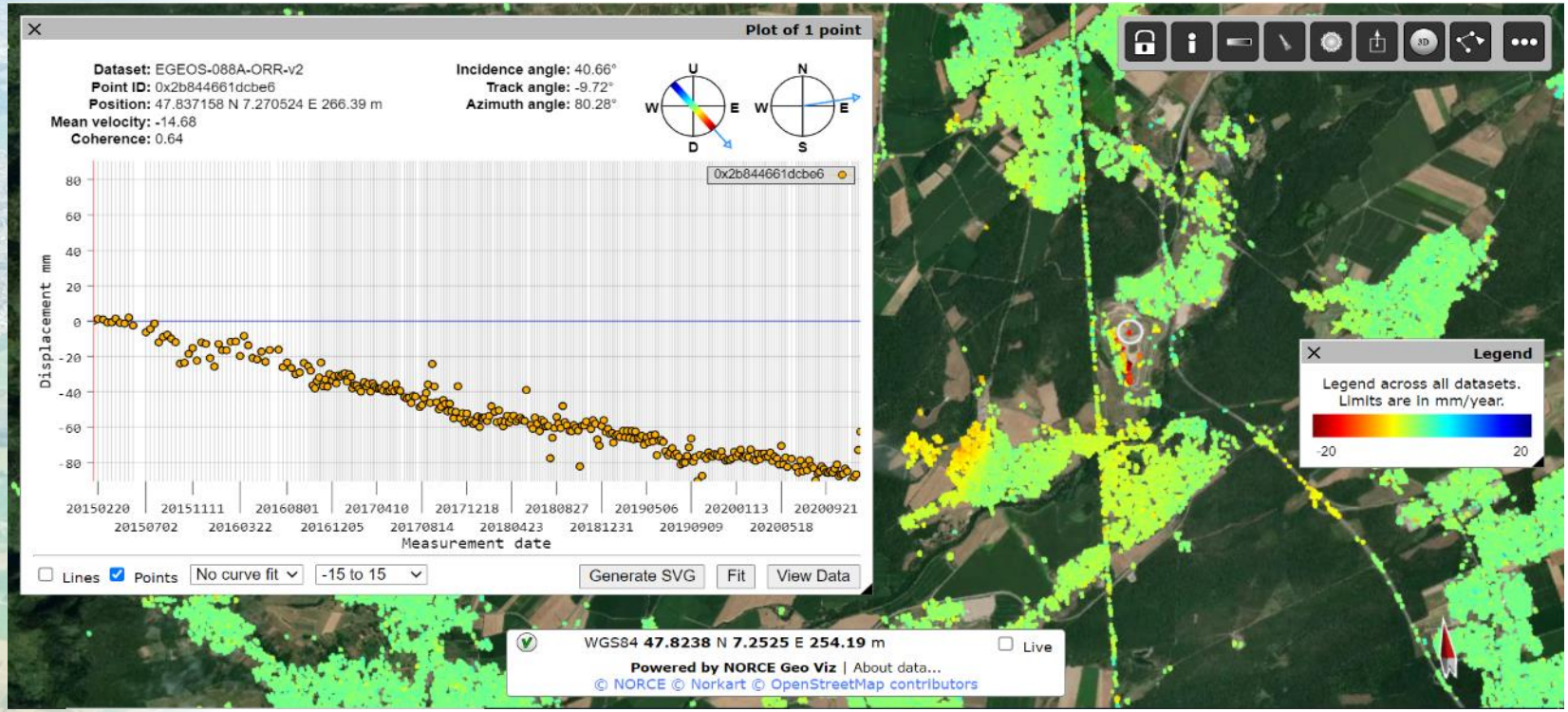
Test Area – Strong and extensive subsidence

http://dev.insar.no/#llh=7.22751582,47.83840729,8630.06821017&look=-0.08444645,-0.74125466,-0.66589063&right=0.99617020,-0.07800572,-0.03949737&up=0.02266567,0.66667581,-0.74500311&layers=aerial,mapbox.satellite,EGEOS-088A-ORR-v2



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Test Area – Strong localized subsidence

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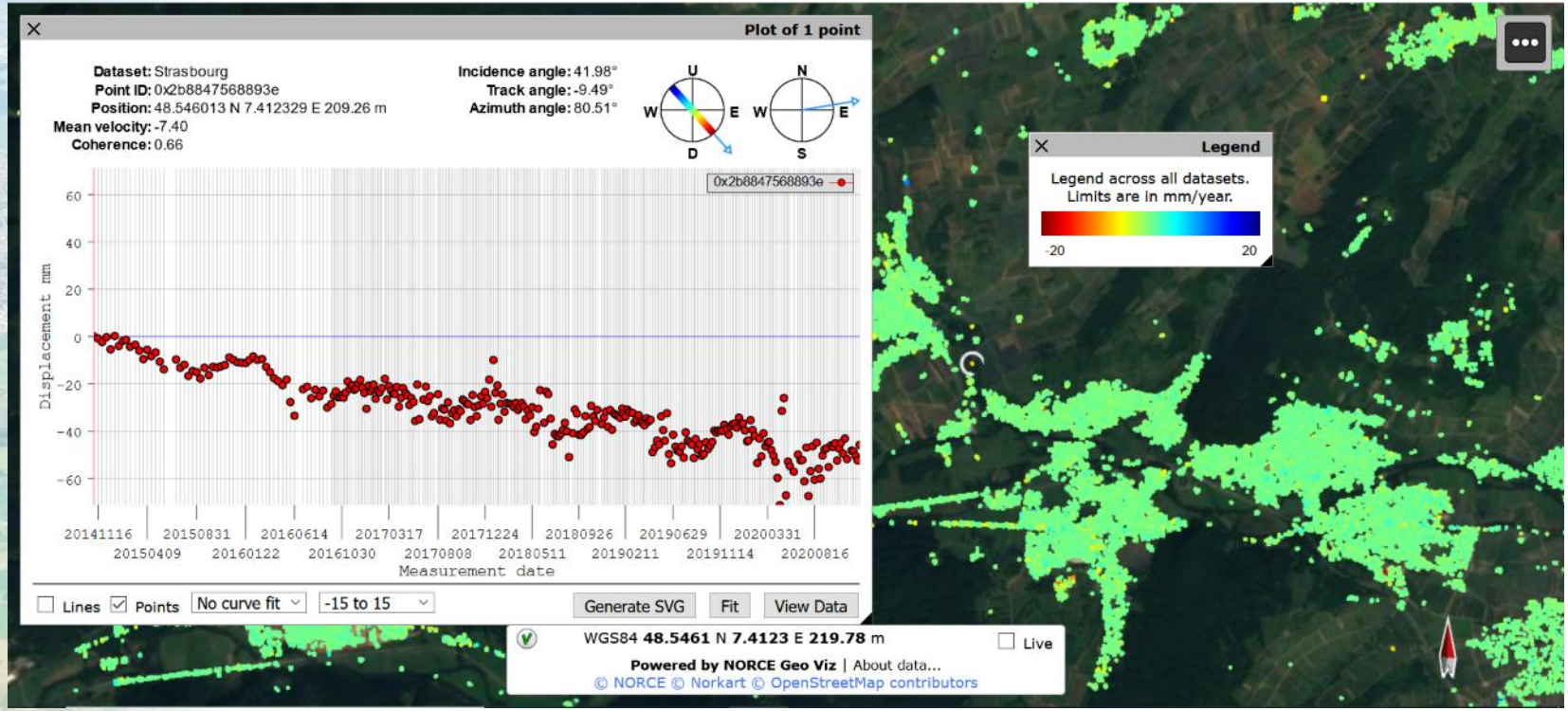

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Test Area – S1 PS on electric pylons

http://dev.insar.no/#llh=7.94936443,48.53761804,240.44984727&look=-0.09873304,0.21753677,-0.97104559&right=0.99385286,-0.02755517,-0.10722501&up=0.05008263,0.97566328,0.21347808&layers=aerial,mapbox.satellite,TREA-ASCENDING-ORR-v2

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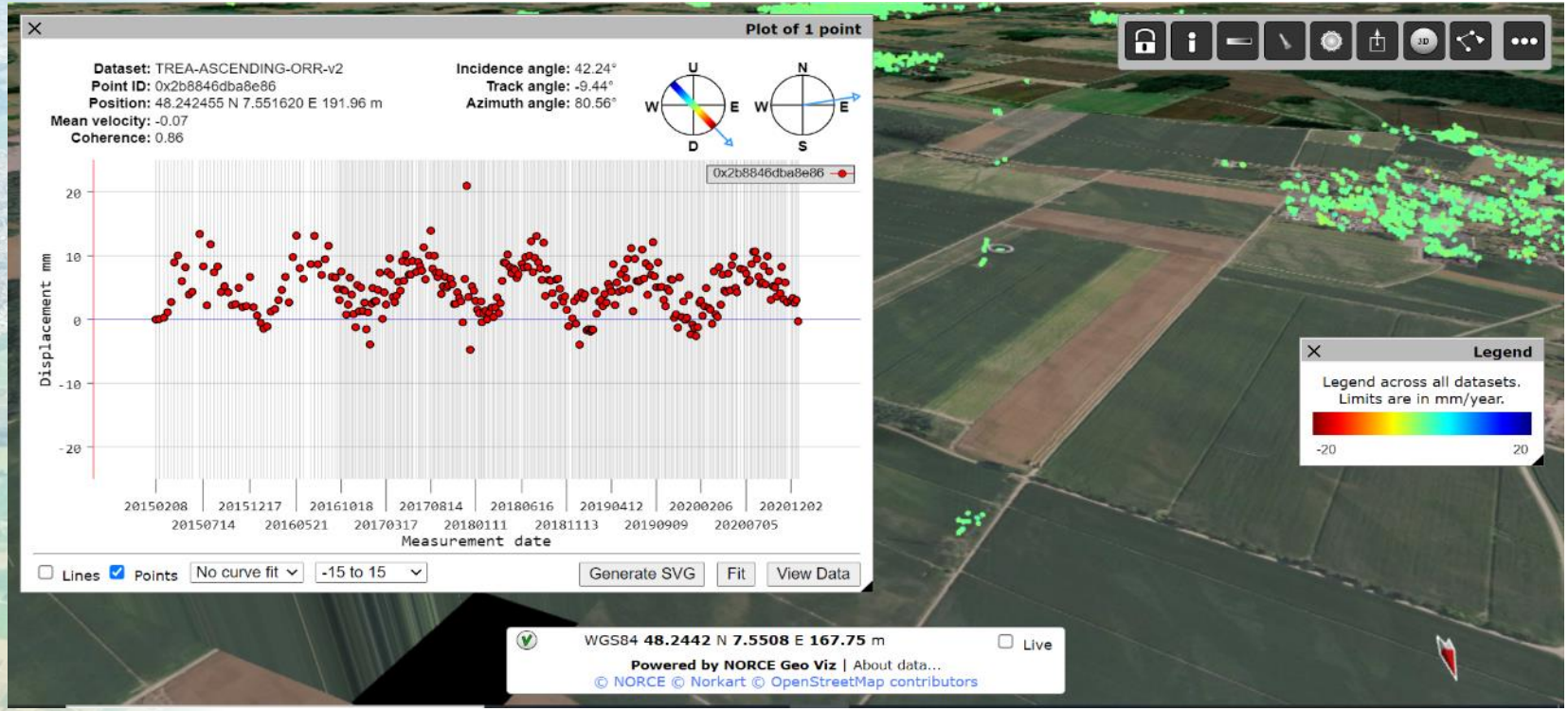
Test Area – Electric pylon thermal expansion

http://dev.insar.no/#llh=7.54926764,48.25236662,574.86485801&look=0.39012283,-0.88094340,0.26784865&right=-0.87309042,-0.26153734,0.41147460&up=0.29243375,0.39438096,0.87117516&layers=aerial,mapbox.satellite,TREA-ASCENDING-ORR-v2



Test Area – An abrupt deformation

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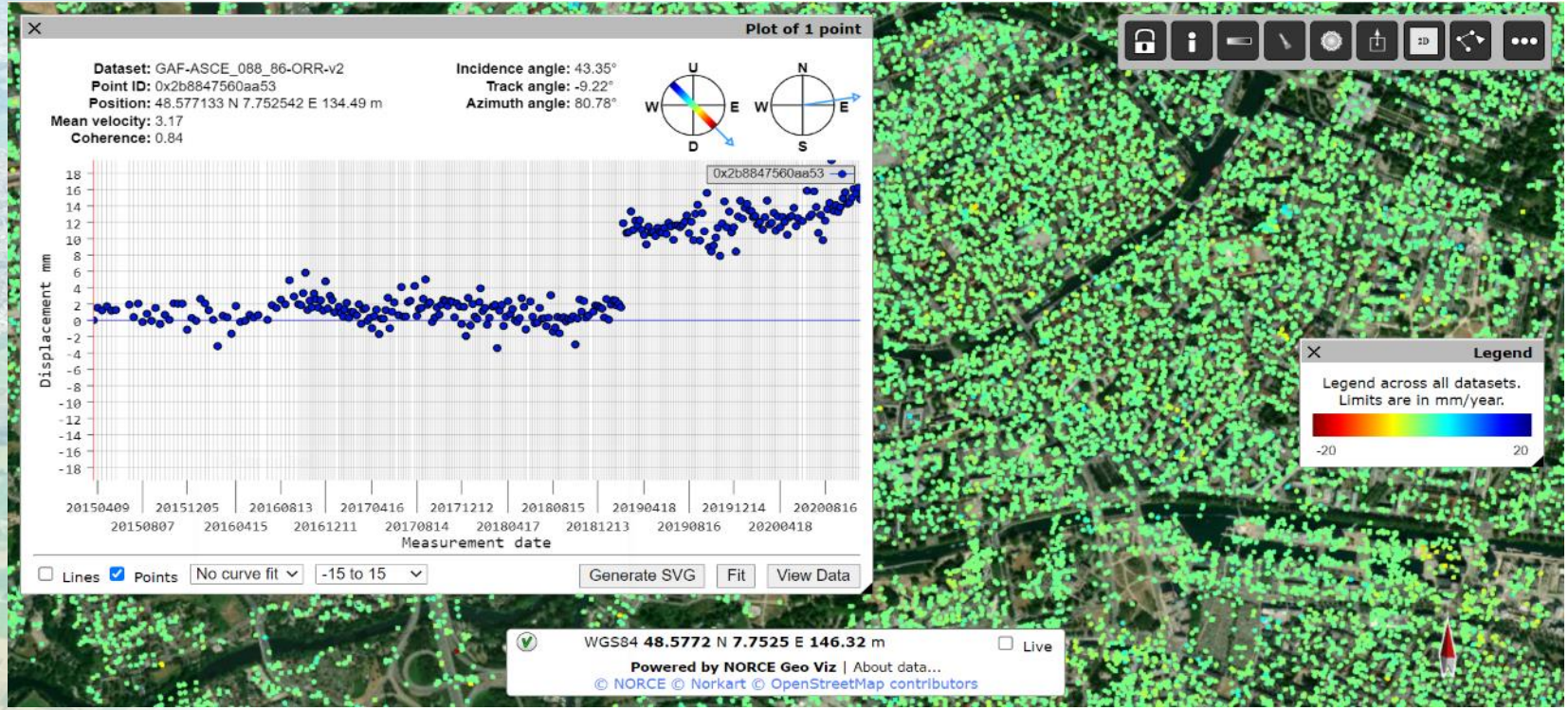
http://dev.insar.no/#llh=7.74275947,48.57871040,2435.67075325&look=-0.08913326,-0.74986529,-0.65555877&right=0.99088293,-0.00000000,-0.13472571&up=-0.10102621,0.66158989,-0.74302929&layers=aerial,mapbox.satellite,GAF-ASCE_088_86-ORR-v2



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  - **Project Coordinator:**
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Next events to date at which EGMS updtates will be presented:

ESA FRINGE 2021	31 May - 04 June 2021
IGARSS 2021	12-16 June 2021

Thank you!